The tripartite structure of pain-related affect:

A confirmatory factor analysis

Charlotte Boichat[1], Christopher Eccleston[1,2], and Edmund Keogh[1,3]

University of Bath

(Accepted: Psychology, Health & Medicine)

[1] Centre for Pain Research, University of Bath, Claverton Down, Bath, BA2 7AY, UK

[2] Department of Clinical and Health Psychology, Ghent University, B-9000 Ghent, Belgium

[3] Department of Psychology, University of Bath, Claverton Down, Bath, BA2 7AY, UK

Correspondence regarding this article should be addressed to: Charlotte Boichat, Centre for Pain Research, University of Bath, Claverton Down, Bath, BA2 7AY, UK. Email address for Christopher Eccleston: c.eccleston@bath.ac.uk. Email address for Edmund Keogh: e.m.keogh@bath.ac.uk.

Funding: The first author (CB) received a University Research Studentship from the University of Bath. The funder had no involvement in the study design, collection, analysis and interpretation of data, writing of report, or decision to submit the article for publication.

Conflict of interest: Charlotte Boichat, Christopher Eccleston, and Edmund Keogh declare that they have no relevant conflicts of interest relating to this study. The research described here formed part of a PhD thesis by the first author, with the co-authors as supervisors.

Abstract

Numerous emotion-based constructs seem related to pain and pain-related disability. These include general affect constructs such as anxiety and depression, as well as specific anxiety-related constructs such as anxiety sensitivity and fear of pain. Few studies examine the relationships between these constructs. Those that have suggest they can be reduced to three or four underlying components. We used a confirmatory approach to test the models of pain-related anxiety found in previous exploratory studies. Adult participants (N = 294) completed commonly used measures of affect-related constructs relevant to pain. Confirmatory Factor Analyses tested three models to determine the best fit. The tripartite model, with small modifications, was found to provide the best fit. The model consisted of: 1) General distress, 2) Fear of pain from injury/insult, and 3) Cognitive intrusion of pain.

Keywords*:* pain, confirmatory factor analysis, assessment, fear, anxiety

1. Introduction

Pain and negative affect are related in clinical and non-clinical groups. Anxiety and depression are common in those with chronic pain (e.g., Gerrits, van Oppen, van Marwijk, Pennix, & van der Horst, 2014; Rayner, Hotopf, Petkova, Matcham, Simpson, & McCracken, 2016), and can increase sensitivity to induced pain in non-clinical groups (e.g., Berna, Leknes, Holmes, Edwards, Goodwin, & Tracey, 2010; Tang & Gibson, 2005). There are also specific anxiety and fear constructs that relate to pain e.g., pain catastrophizing, fear of pain, pain anxiety, anxiety sensitivity (Etherton, Lawson, & Graham, 2014; Lazaridou, Franceschelli, Buliteanu, Cornelius, Edwards, & Jamison, 2017; Ocanez, McHugh, & Otto, 2010; Pierik, Ijzerman, Gaakeer, Vollenbroek-Hutten, Van Vugt, & Doggen, 2016).

Theoretically, these constructs have distinct roles in both clinical and non-clinical pain. For example, in the Fear-Avoidance Model (Leeuw, Goossens, Linton, Crombez, Boersma, & Vlaeyen, 2007), there are several constructs which when experienced following injury, contribute to the development of persistent pain e.g., negative affectivity, catastrophizing, fear of pain, pain anxiety. These lead to avoidance and escape behaviours which can result in disuse, disability, and depression. The model also shows how a lack of fear of pain can result in confrontation and recovery. The Hierarchical Model of Negative Emotionality outlines how these various constructs may be related: with negative emotionality, and trait anxiety, as higher-order factors, the three fundamental fears as mid-level factors, and pain catastrophizing and fear of pain as lower-order factors (Keogh & Asmundson, 2004). However, these constructs also relate to each other. For example, negative affectivity is thought to be a shared factor in anxiety and depression (Clark & Watson, 1991). Additionally, the fundamental fears of anxiety sensitivity, illness/injury sensitivity, and fear of negative evaluation, are conceptually related, but considered distinct constructs (Taylor, 1993).

While the relationship between these constructs and pain is established, it is unclear whether these various constructs are empirically distinct and individual processes, or if there is overlap, and redundancy. This is surprising, as better understanding would bring practical and theoretical benefits. For example, reducing the assessment and measurement burden on patients brings obvious advantages. To address this, some have suggested the anxiety-related measures could be conceptualised around core domains. For example, when Mounce, Keogh, & Eccleston (2010) conducted a Principal Components Analysis (PCA) on common self-report measures of emotion-related pain, three underlying domains emerged: '*General distress*', '*Fear of pain from injury/insult*', and '*Cognitive intrusion of pain*'. Others, varying in methods or measures, come to similar conclusions, suggesting three or four components (Lee, Watson, & Frey-Law, 2013; Moore, Eccleston, & Keogh, 2013; Vancleef, Peters, Roelofs, & Asmundson, 2006; Vancleef, Peters, & Vlaeyen, 2011; Vancleef, Vlaeyen, & Peters, 2009).

Although converging evidence supports a tripartite structure to anxious responding in pain, studies to date have been exploratory in nature. There is now a need to move to more theoretically informed confirmatory techniques, which allow a different, more directed, test of the predicted structure. The primary aim of this study was, therefore, to confirm the hypothesised three-factor structure of pain-related anxiety. We sought to administer the same instruments used by Mounce et al. (2010) and conduct Confirmatory Factor Analysis (CFA) to assess the reliability of their proposed model. This approach also helps us refine and develop current models of pain (Crombez, Eccleston, Van Damme, Vlaeyen, & Karoly, 2012), and so we sought to compare different, alternative, factor structures. Since pain is a normal aspect of human experience, confirming that these constructs exist within pain-free populations is an important first step in identifying possible vulnerability factors that might contribute to the development of chronic conditions (Vancleef et al., 2006; Leeuw et al., 2007).

2. Methods

2.1 Participants

Since the goal of this study was to confirm the tripartite factor structure previously reported by Mounce et al. (2010), the same sampling technique (non-clinical pain) and measures used in the original study was adopted. Two hundred and ninety four participants were recruited from a University in the South West of England, which is above the minimum required number (178) based on model degrees of freedom and effect size (MacCallum, Browne, & Sugawari, 1996; Tabachnick & Fidell, 2013). Inclusion criteria were self-reported good general health and aged 18 or over. Demographic information can be found in Table 1.

2.2 Measures and Procedure

Following University Ethical Committee approval, recruited participants provided informed consent, and completed the following questionnaires:

1. Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) - negative affectivity subscale.
2. Trait form of the Spielberger State/Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).
3. Depression Anxiety and Stress Scale (DASS 21; Lovibond & Lovibond 1995).
4. Illness/Injury Sensitivity Index (ISI; Taylor, 1993).
5. Pain Catastrophizing Scale (PCS; Sullivan, Bishop, & Pivik, 1995).
6. Pain Anxiety Symptoms Scale (PASS 20; McCracken & Dhingra 2002).

7. Fear of Pain Questionnaire III (FPQ III; McNeil & Rainwater 1998).
8. Brief Fear of Negative Evaluation Scale (FNES; Leary, 1983).
9. Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & Mcnally, 1986).

These measures were the same as those used by Mounce et al (2010), and were included because they are commonly used, and relevant to pain models. All measures have been validated and used in non-clinical groups. Subscale totals were calculated, and total scores for those without subscales. Further information about the measures, including their psychometric properties, are in supplementary material.

2.3 Statistical Approach

Confirmatory Factor Analysis (CFA) was conducted using AMOS (Arbuckle, 2007). Relationships between variables are specified a priori (Byrne, 2010), and based on the model proposed by Mounce et al. (2010): ‘Fear of pain from injury/insult’, ‘General distress’, and ‘Cognitive intrusion of pain’. Figure 1 displays the model, showing that the underlying components are allowed to correlate (double headed arrows), and how they relate to the measured variables (single headed arrows). The model also shows error associated with each measured variable.

An alternative models approach was taken, where 2 and 4 component models were compared. These were chosen for comparison, since Mounce et al. (2010) offered them as possible alternative solutions. Figure 2 shows the two factor model: the same ‘General distress’, and a second combined ‘Fear and anxiety about pain’ factor.

Figure 3 shows the four component model, where fear of injury and fear of illness formed separate factors. These models were compared using goodness of fit tests, and a model modification approach used to improve fit (Byrne, 2010).

Tables 1-3 here

----

3. Results

3.1 Descriptive Statistics

Descriptive statistics are presented in Table 2. Although some scales/subscales were non-normally distributed, none exceeded cut off skewness and kurtosis values for CFA (Curran, West, & Finch, 1996). The sample reported low levels of depression and anxiety (Lovibond & Lovibond, 1995), average scores on the PCS (Sullivan et al., 1995), lower scores than a clinical sample on the PASS (McCracken & Dhingra, 2002), and similar scores to a university sample on the FPQ (Roelofs, Peters, Deutz, Spijker, & Vlaeyen, 2005).

3.2 Three Factor Model

The three component model (model 1) was tested first. Table 3 presents the full fit indices for model 1, which suggests that it was not a particularly good fit to the data. Specifically, NFI (Normed Fit Index) = .78, and CFI (Comparative Fit Index) = .83, when a value of > .90 would represent a well fitted model. Furthermore, TLI (Tucker Lewis Index) = .80, when a value of > .95 would indicate a good fit.

Since there may be misfit within the model, ‘modification indices’ (MIs) and ‘expected parameter change’ (EPC) were used to re-specify the model (Byrne, 2010). These suggested co-variances between the error of the Fear of Pain Questionnaire subscales, severe pain and medical pain (MI = 20.57, EPC = 10.69), and between the error of the Fear of Pain Questionnaire subscales, medical pain and minor pain (MI = 51.23, EPC = 13.20). In addition, high MI and EPC scores suggested co-variances between the error of the Illness/Injury Sensitivity Index subscales, fear of illness and fear of injury. Since these co-variances involved subscales from the same measures it was assumed some error is non-random and due to overlapping content. The model was adjusted, allowing these errors to co-vary (see Figure 1).

When retested, fit indices improved from the first model (χ^2 (183) = 632.68, CFI = .86) (see Table 3). We also looked for a change in χ^2 value ($\Delta\chi^2$), where the higher the value, the closer the fit between the hypothesised model and the perfect fit. A change in χ^2 value of 7.82 between models 1 and 2 is necessary (at a significance level of p = 0.05, with a change of three degrees of freedom) to be a statistically better model. The $\Delta\chi^2$ value = 126.11 suggesting that model 2 is a statistically better fit to the data than model 1. For model 2, NFI = .82 and CFI = .86 and so were not too far from the suggested value of > .90 for a good fit. Similarly, TLI = .84 which is not far from the suggested value .95 for a good fit. The PCFI (Parsimony Comparative Fit Index) for model 2 was .75, not far from the expected .785 for a good fit, and RMSEA (Root Mean Square Error of Approximation) was .09 which indicates mediocre fit. Although the model was not excellent, fit indices were near acceptable levels.

Figures 1-3 here

3.3 Two Factor Model

Since two and four component solutions were examined by Mounce et al. (2010) we also considered them. Fit indices for model 3, the two-factor model (see Table 3 and Figure 2), suggested that it was not a good fit. There was a less satisfactory fit when compared to model 1 (the initial three factor model), and an overall increase in χ^2 (χ^2 (188) = 957.11, CFI = .77). Model 3 was rejected. It was not re-specified as only the best fitting models out of the two, three, and four factor solutions, were retained and re-specified to improve fit.

3.4 Four Factor Model

Model 4 tested the four-factor model. Fit indices (see Table 3) were slightly better than those found for model 1 (three factor model) (χ^2 (183) = 689.91, CFI = .85). The model was therefore re-specified. Co-variances or regression paths with both large MIs and large EPCs, and were paths made theoretical sense were altered. As with the 3 factor model, values suggested that error in the Fear of Pain Questionnaire subscales should be allowed to co-vary: severe pain and medical pain (MI = 10.00, EPC = 7.06), medical pain and minor pain (MI = 30.72, EPC = 9.27). Therefore the model was tested again, allowing errors to co-vary (model 5; see Figure 3 and Table 3).

The CFA of model 5 generated fit indices similar to those found for model 2 (three factor model with three error co-variances) (χ^2 (181) = 629.55, CFI = .86). Change in χ^2 was examined between model 2 and 5, with a 5.99 change required (at a significance level of p = 0.05, with a change of two degrees of freedom), for model 5 to be a statistically better model. The $\Delta\chi^2$ value = 3.13 suggests model 5 was not a statistically better fit to the data than model 2. An additional model comparison technique is to examine the AIC (Akaike's, 1987, information criterion) values, which addresses the issue of parsimony in the assessment of model fit; a smaller value is indicative of a better fit. The lowest AIC value belongs to model 2, suggesting this provided a marginally better fit.

4. Discussion

This study successfully investigated the adequacy of the tripartite model of negative affect-related constructs relevant to pain. The best fit to the data appeared to be the three and four factor models. The three factors were: '*General distress*', and two pain-specific factors '*Fear of pain from injury/insult*', and '*Cognitive intrusion of pain*'. The four-factor model simply separates fear of illness and injury, making them more distinct from a fear of pain per se. However, they are all conceptually related constructs: fear surrounding pain is linked with fears around body/physical sensations. Since others suggest fear of illness and injury form an underlying fear of pain construct (Carleton, Park, & Asmundson, 2006), the tripartite model was selected.

The findings of this study also suggest a possible lack of economy in employing a large number of questionnaires, and maybe some redundancy. Developing a concise self-report questionnaire that captures the core components could increase accuracy and reduce the demand on patients and research participants. Alternatively, focusing on just one core construct may be sufficient. For example, Attridge, Crombez, Van Ryckeghem, Keogh & Eccleston (2015) focused on the cognitive intrusion of pain component, developing a single construct measure. Of course, prudence is warranted in developing concise measures (Vancleef et al., 2011), as this may risk removing key aspects that have important explanatory power. However, a more focused approach may provide a better understanding of an individual's emotional pain profile, while complete measures provide deeper understanding.

These results also inform how we think about the relationships between constructs. For example, Vancleef et al. (2009) argued that 'negative emotions and anxiety' represents a higher level construct, whereas a second cluster of 'cognitive performance and physical health concerns' represent a mid-level construct, and a more specific cluster of 'pain-specific concerns' represent the lowest level of the model. Our findings may also reflect this hierarchical model: general distress representing the highest level, the fear of pain from injury/insult factor (including fear of pain) mid-level constructs, and the cognitive intrusion of pain factor representing the lowest first level. The results found here suggest that pain catastrophizing may not be as closely related to illness/injury sensitivity as thought.

These findings may be relevant to those interested in the fear avoidance model of pain (Leeuw et al., 2007). Not all constructs in the tripartite model are present in the fear-avoidance model, and some are portrayed as separate constructs, although they load onto the same component here (Asmundson, Norton, & Vlaeyen, 2004). Fear of pain is thought to be an important construct in the development of chronic pain (Trost, France, & Thomas, 2011; Linton, Buer, Vlaeyen & Hellsing, 2000; Crombez et al., 2012). Our results suggest that anxiety sensitivity and illness/injury sensitivity are closely related to fear of pain, and may require a more prominent role in the fear-avoidance model. Since pain catastrophizing and pain anxiety load onto the same component, it may be useful to utilize the more comprehensive component of 'cognitive intrusion of pain', which encompasses both constructs. Additionally, although pain-related fear and pain-related anxiety are sometimes considered interchangeable, our findings suggest they may be distinct concepts (Asmundson et al., 2004).

Since fear has already been established as playing a role in the experience and development of chronic pain (Crombez et al., 2012), it would also be interesting to consider the implications of our findings in this context. For example, if the three-factor solution was also found in a chronic pain population, it would suggest that the fear of painful sensations are closely entwined with representations of body damage (injury). However, if the four-factor solution was preferred in pain populations, this may suggest that the fear of pain is specifically concerned with the sensation of pain, while a fear of suffering from illness and injury is distinct. This could influence different areas of fear to focus in on during assessment and intervention.

In terms of limitations, we need to be mindful that there may be dissociation between the theoretical constructs of interest and the questionnaires designed to measure them. It is useful therefore to examine not just a single construct, but a more comprehensive related set of constructs (Nicholls, Licht, & Pearl, 1982). However, whilst the measures used here reflect those often used in pain research, this choice may reflect researchers' attachments to particular constructs and/or questionnaires. We may be missing something. However, given that Vancleef et al. (2009) reported similar outcomes despite using slightly different questionnaires suggest the underlying core components may be robust. Secondly, it must not be presumed that the same model would be found in a clinical pain population. Whilst these measures have been used in both clinical and non-clinical groups, it would be useful to confirm the stability of our tripartite factor structure with other samples. It would be interesting to see whether the same structure occurs in different pain groups, and whether the development of pain produces changes in how these constructs relate. It would also be interesting to see whether these individual core constructs contribute to the development of chronic pain following an injury in different ways (Leeuw et al., 2007).

In conclusion, a small number of studies have shown that the numerous anxiety-related constructs often utilised in the area of pain may be subsumed by a smaller number of core components. This may be useful for further understanding of these constructs and for potentially developing a more concise way of measuring them in the future.

References

Akaike, H. (1987). Factor Analysis and AIC. *Psychometrika, 52,* 317-332.

Arbuckle, J. L. (2007). *Amos 16.0 User's Guide,* Chicago: SPSS.

Asmundson, G. J., Norton, P. J., & Vlaeyen, J. W. S. (2004). Fear-avoidance models of chronic pain: an overview. In G. J. Asmundson, J. W. S. Vlaeyen, G. Crombez, (Eds.), *Understanding and treating fear of pain* (pp. 3 – 24). Oxford: Oxford University Press.

Attridge, N., Crombez, G., Van Ryckeghem, D., Keogh, E., & Eccleston, C. (2015). The experience of cognitive intrusion of pain: scale development and validation. *Pain, 156,* 10, 1978-90.

Berner, C., Leknes, S., Holmes, E. A., Edwards, R. R., Goodwin, G. M., & Tracey, I. (2010). Induction of depressed mood disrupts emotion regulation neurocircuitry and enhances pain unpleasantness. *Biological Psychiatry, 67,* 1083-1090.

Byrne, B. M. (2010). *Structural Equation Modelling with AMOS: Basic Concepts, Applications and programming.* New York: Routledge Taylor & Francis Group.

Carleton, R. N., Park, I., & Asmundson, G. J. (2006). The Illness/Injury Sensitivity Index: an examination of construct validity. *Depression & Anxiety, 23,* 340-346.

Clark, L. A., & Watson, D. (1991). Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology, 100,* 316-336.

Crombez, G., Eccleston, C., Van Damme, S., Vlaeyen, J.W.S., & Karoly, P. (2012). The fear avoidance model of chronic pain: the next generation. *Clinical Journal of Pain, 28,* 475-483.

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods, 1,* 16-29.

Etherton, J., Lawson, M., & Graham, R. (2014). Individual and gender differences in subjective and objective indices of pain: gender, fear of pain, pain catastrophizing and cardiovascular reactivity. *Applied Psychophysiology Biofeedback, 39,* 89-97.

Gerrits, M. M. J. G., van Oppon, P., van Marwijk, H. W. J., Penninx, B. W. J. H., & van der Horst, H. E. (2014). Pain and the onset of depressive and anxiety disorders. *Pain, 155,* 53-59.

Keogh, E., & Asmundson, G. J. (2004). Negative affectivity, catastrophizing, and anxiety sensitivity. In G. J. Asmundson, J. W. S. Vlaeyen, G. Crombez, (Eds.), *Understanding and treating fear of pain* (pp. 91-115). Oxford: Oxford University Press.

Lazaridou, A., Franceschelli, O., Buliteanu, A., Cornelius, M., Edwards, R. R., & Jamison, R. N. (2017). Influence of catastrophizing on pain intensity, disability, side effects, and opioid misuse among pain patients in primary care. *Journal of Applied Biobehavioural Research, 22,* 1-13.

Leary, M. R. (1983). A brief version of the fear of negative evaluation scale. *Personality & Social Psychology Bulletin, 9,* 371-375.

Lee, J. E., Watson, D., & Frey-Law, L. A. (2013). Psychological factors predict local and referred experimental muscle pain: a cluster analysis in healthy adults. *European Journal of Pain, 17,* 903-915.

Leeuw, M., Goossens, M. E. J. B., Linton, S. J., Crombez, G., Boersma, K., & Vlaeyen, J. W. S. (2007). The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *Journal of Behavioral Medicine, 30,* 77-94.

Linton, S. J., Buer, N., Vlaeyen, J., & Hellsing, A-L. (2000). Are fear-avoidance beliefs related to the inception of an episode of back pain? A prospective study. *Psychology and Health, 14,* 1051-1059.

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for Depression Anxiety Stress Scales.* Sydney: Psychology Foundation.

MacCallum, R. C., Browne, M. W., & Sugawari, H. M. (1996). Power Analysis and Determination of Sample Size for Covariance Structure Modeling. *Psychological Methods, 1,* 130-149.

McCracken, L. M., & Dhingra, L. (2002). A short version of the pain anxiety symptoms scale (PASS-20): preliminary development and validity. *Pain Research & Management, 7,* 45-50.

McNeil, D. W., & Rainwater, A. J. (1998). Development of the Fear of Pain Questionnaire - III. *Journal of Behavioral Medicine, 21*, 389-410.

Moore, D. J., Eccleston, C., & Keogh E. (2013). Does sex moderate the relationship between anxiety and pain? *Psychology & Health, 28,* 746-764.

Mounce, C., Keogh, E., & Eccleston, C. (2010) A principal components analysis of negative affect-related constructs relevant to pain: evidence for a three component structure. *The Journal of Pain, 11,* 710-717.

Nicholls, J. G., Licht, B. G., & Pearl, R. A. (1982). Some dangers of using personality questionnaires to study personality. *Psychological Bulletin, 92,* 572-580.

Ocanez, K. L. S., McHugh, R. K., & Otto, M. W. (2010). A meta-analytic review of the association between anxiety sensitivity and pain. *Depression and Anxiety, 27,* 760-767.

Pierik, J.G.J., Ijzerman, M.J., Gaakeer, M.I., Vollenbroek-Hutten, M.M.R., Van Vugt, A.B., & Doggen, C.J.M. (2016). Incidence and prognostic factors of chronic pain after isolated musculoskeletal extremity injury. *European Journal of Pain, 20,* 711-722.

Rayner, L., Hotopf, M., Petkova, H., Matcham, F., Simpson, A., & McCracken, L. M. (2016). Depression in patients with chronic pain attending a specialised pain treatment centre: prevalence and impact on health care costs. *Pain, 157,* 1472-1479.

Reiss, S., Peterson, R. A., Gursky, D. M., & Mcnally, R. J. (1986). Anxiety sensitivity, anxiety frequency and the prediction of fearfulness. *Behaviour Research & Therapy, 24,* 1-8.

Roelofs, J., Peters, M. L., Deutz, J., Spijker, C., & Vlaeyen, J. W. S. (2005). The Fear of Pain Questionnaire (FPQ): Further psychometric examination in a non-clinical sample. *Pain, 116,* 339-346.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-trait Anxiety Inventory (Form Y).* Palo Alto, CA: Consulting Psychology Press.

Sullivan, M. J. L., Bishop, S. R., & Pivik, J. (1995). The Pain Catastrophizing Scale: development and validation. *Psychological Assessment, 7,* 524-532.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics, 6th ed.* Boston: Pearson Education Inc.

Tang, J., & Gibson, S. J. (2005). A psychophysical evaluation of the relationship between trait anxiety, pain perception, and induced state anxiety. *The Journal of Pain, 6,* 612-619.

Taylor, S. (1993). The structure of fundamental fears. *Journal of Behavior Therapy & Experimental Psychiatry, 24,* 289-299.

Trost, Z., France, C. R. & Thomas, J. S. (2011). Pain-related fear and avoidance of physical exertion following delayed-onset muscle soreness. *Pain, 152,* 1540-1547.

Vancleef, L. M. G., Peters, M. L., Roelofs, J., & Asmundson, G. J. (2006). Do fundamental fears differentially contribute to pain-related fear and pain catastrophizing? An evaluation of the sensitivity index. *European Journal of Pain, 10,* 527-536.

Vancleef, L. M. G., Peters, M. L., & Vlaeyen, J. W. S. (2011). Negative emotional constructs relevant to pain: Unique variability, content overlap and interrelations: A comment on Mounce, Keogh, and Eccleston (2010). *The Journal of Pain, 12,* 304-305.

Vancleef, L. M. G., Vlaeyen, J. W. S., & Peters, M. L. (2009). Dimensional and componential structure of a hierarchical organisation of pain-related anxiety constructs. *Psychological Assessment, 23,* 340-351.

Watson, D., Clark, A. C., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative effect: the PANAS Scales. *Journal of Personality & Social Psychology, 54,* 1063-1070.

Table 1 Demographic details of the sample

	Mean or Proportion
Age	
Full sample	25.4 (SD 8.6)
Male	24.3 (SD 6.7)
Female	26.4 (SD 9.8)
Missing	1.0%
Sex	
Male	46.66%
Female	53.1%
Missing	0.3%
Occupation	
Students	69.4%
Non-manual	28.2%
Manual (skilled and unskilled)	1.7%
Missing	0.7%
Ethnic group	
White European	89.5%
Chinese	3.1%
Indian	2.0%
Other ethnicities	8.3%

Table 2 Descriptive statistics for the various questionnaire subscales or totals

	Mean total score	Standard deviation	Range	Possible range	Chronbach's alpha
FNES	36.70	10.20	15-60	12-60	.92
PANAS-NA	17.30	6.05	10-43	10-50	.87
STAI-t	41.80	10.20	23-72	20-80	.92
DASS depression	4.03	3.78	0-18	0-21	.83
DASS anxiety	2.79	2.82	0-18	0-21	.73
DASS stress	6.50	4.18	0-20	0-21	.81
ISI illness	17.73	5.59	7-35	6-30	.85
ISI injury	8.52	3.64	4-20	5-25	.87
PCS rumination	7.09	4.08	0-16	0-16	.89
PCS magnification	3.30	2.44	0-12	0-12	.68
PCS helplessness	6.78	4.57	0-23	0-24	.84
PASS fearful appraisal	5.22	4.36	0-24	0-25	.82
PASS cognitive anxiety	9.97	5.44	0-25	0-25	.86
PASS physiological anxiety	6.27	4.40	0-21	0-25	.73
PASS escape and avoidance behaviour	8.18	4.94	0-22	0-25	.75
FPQ minor	17.73	5.86	10-41	10-50	.85
FPQ severe	33.84	8.09	10-50	10-50	.89
FPQ medical	24.73	8.01	10-48	10-50	.89
ASI physical concerns	15.90	5.05	8-38	8-40	.83

ASI mental concerns	6.35	2.56	4-19	4-20	.76
ASI social concerns	10.78	2.65	5-18	4-20	.50

FNES = Fear of Negative Evaluation Scale, PANAS-NA = Positive and Negative Affectivity Scale – negative affect subscale, STAI-t = Spielberger State-Trait Anxiety Inventory – Trait version, DASS = Depression, Anxiety, Stress Scale, ISI = Injury/Illness Sensitivity Index, PCS = Pain Catastrophizing Scale, PASS = Pain Anxiety Symptoms Scale, FPQ = Fear of Pain Questionnaire, ASI = Anxiety Sensitivity Index.

Table 3 Summary of re-specification steps from initial to final model

Models	χ^2	*df*	*NFI*	*CFI*	*TLI*	*PCFI*	*RMSEA*	*AIC*
Model 1 (3 factor)	758.79	186	.78	.83	.80	.73	.10	890.79
Model 2 (3 factor with changes)	632.68	183	.82	.86	.84	.75	.09	770.68
Model 3 (2 factor)	957.11	188	.73	.77	.74	.69	.12	1085.11
Model 4 (4 factor)	689.91	183	.80	.85	.82	.74	.10	827.91
Model 5 (4 factor with changes)	629.55	181	.82	.86	.84	.74	.09	771.55

Df = degrees of freedom, NFI = Normed Fit Index, CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, PCFI = Parsimony Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, AIC = Akaike's Information Criterion

Figure captions

Figure 1. Model 2: Confirmatory Factor Analysis of the three factor model of constructs related to pain and negative affect with modifications

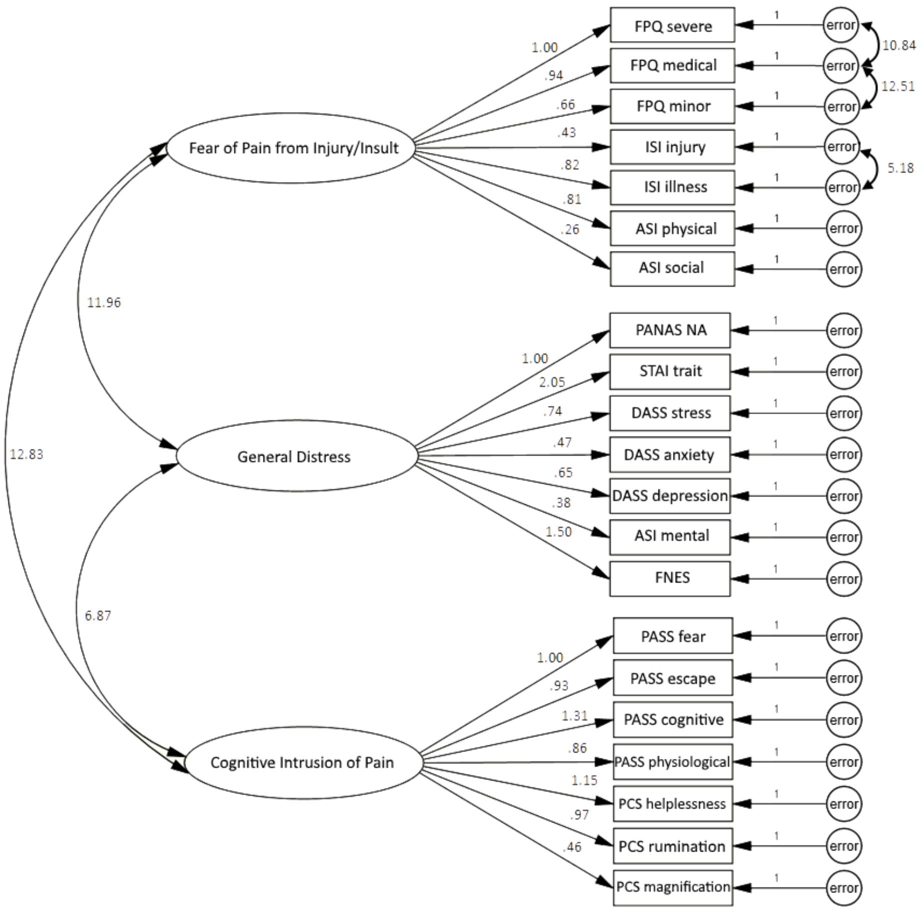


Figure 2. Model 3: Confirmatory Factor Analysis of the two factor model of constructs related to pain and negative affect

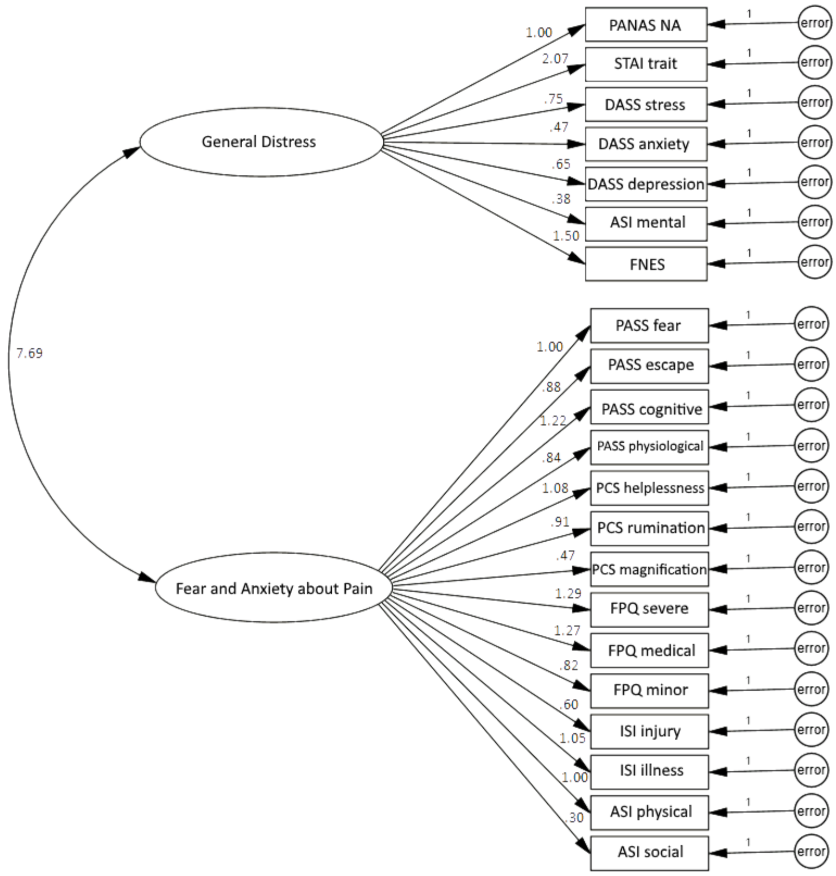
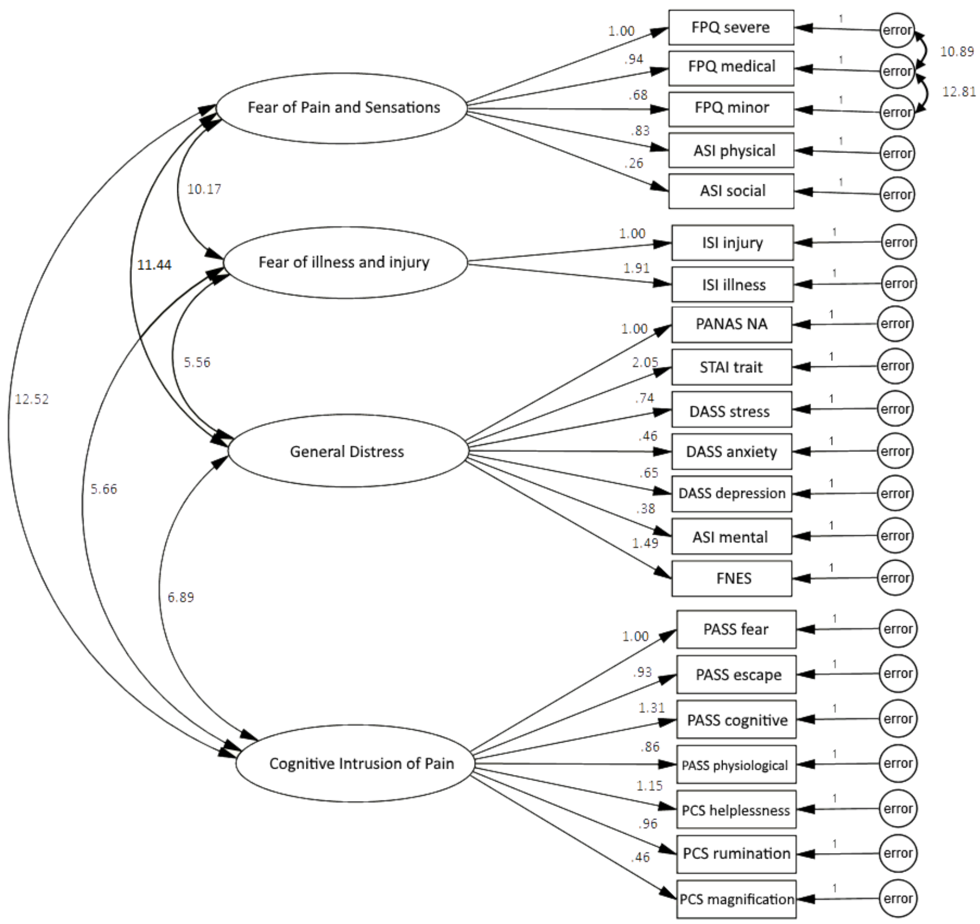


Figure 3. Model 5: Confirmatory Factor Analysis of the four factor model of constructs related to pain and negative affect with modifications



Supplementary Material Psychometric properties of measures used

Measure	Number of items	How it is rated	Psychometric properties
Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) - negativity affectivity subscale only.	10 items.	5 point Likert scale (1 = very slightly or not at all, 5 = extremely).	Internal consistency: α = .84 to .87. Temporal stability: r = .74 Concurrent validity: r = .51 to .74.
Trait form of the Spielberger State/Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).	20 items.	4 point Likert scale (1= almost never, 4 = almost always).	Internal consistency: α = .89 to .91. Temporal stability: r = .65 to .86. Concurrent validity: r = .73 to .85.
Depression Anxiety and Stress Scale (DASS 21; Lovibond and Lovibond 1995).	21 items; 3 subscales measuring depression, anxiety and stress.	4 point Likert scale (0 = Did not apply to me at all, 3 = applied to me very much, or most of the time).	Internal consistency: α = .94 depression, .87 anxiety, .91 stress. Concurrent validity: r = .79 to.85).
Illness/Injury Sensitivity Index (ISI; Taylor 1993; Carleton et al, 2005).	11 items; 2 subscales: fear of illness and fear of injury.	5 point Likert scale (0 = very little, 4 = very much).	Internal consistency: α = .84 to .86.
Pain Catastrophizing Scale (PCS; Sullivan, Bishop, and Pivik, 1995).	13 items; 3 subscales: rumination, magnification, and helplessness.	5 point Likert scale (0 = not at all, 4 = all the time).	Internal consistency: α = .60 to .95. Temporal stability: r = .70.
Pain Anxiety Symptoms Scale (PASS 20; McCracken and Dhingra 2002).	21 items; 4 subscales: fearful appraisals of pain, cognitive anxiety, physiological anxiety, and escape and avoidance behaviour.	6 point Likert scale (0 = never, 5 = always).	Internal consistency: α = .67 to .92. Convergent validity: r = .34 to .63.
Fear of Pain Questionnaire III (FPQ III; McNeil and Rainwater 1998).	30 items; 3 subscales: fear of severe pain, fear of minor pain, and fear of medical pain.	5 point Likert scale (1 = not at all, 5 = extreme).	Internal consistency: α = .82 to .93. Temporal stability: r = .69 to .76.
Brief Fear of Negative Evaluation Scale (FNES; Leary 1983).	12 items.	6 point Likert scale (1 = not at all characteristic of me, 5 = extremely characteristic of me).	Internal consistency: α = .90. Temporal stability: r = .75.
Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986).	16 items; 3 subscales: physical concerns, social concerns, and mental concerns.	5 point Likert scale (0 = very little, 4 = very much).	Internal consistency: α = .82 to .88. Temporal stability: r = .71 to .75.